भारतीय मानक
Indian Standard

IS 11327 : 2022

प्रशीतन संघनन इकाइयों की अपेक्षाएँ

(दूसरा पुनरीक्षण)

Requirements for Refrigerant Condensing Units

(Second Revision)

ICS 97.130.20

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Refrigeration and Air Conditioning Sectional Committee, MED 03

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Refrigeration and Air Conditioning Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was first published in 1985 and subsequently revised in 2007.

The experience gained over a period as well as the change in usage conditions, refrigerant changes, etc. has necessitated this revision.

The purpose of this standard is to provide guidelines for positive displacement condensing units. The major additions in this revision are as follows:

a) Definitions;
b) Constructional/safety requirements;
c) Testing requirements;
d) Rating/minimum data requirements for published ratings;
e) Operating requirements;
f) Marking and nameplate data; and
g) Conformance conditions.

In the formulation of this standard considerable assistance has been derived from the following International Standards:

ANSI/AHRI 520-2004	Performance rating of positive displacement condensing units
IEC 60335-1 : 2020	Safety of household and similar electrical appliances — Part 1: General requirements

The composition of the Committee, responsible for the formulation of this standard is given at Annex E.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

REQUIREMENTS FOR REFRIGERANT CONDENSING UNITS

(Second Revision)

1 SCOPE

1.1 This standard cover requirement of condensing units built with electric motor driven by fixed speed and variable speed positive displacement compressors for commercial and industrial applications. The condensing units could be air cooled or water cooled, having single stage and two stage compressor of open type, hermetic and semi-hermetic construction.

1.2 The standard is applicable to condensing units operating on the vapor compression cycle using refrigerants like HFC/HCFC, natural or A2L/A3 refrigerants. The requirements of high-pressure refrigerants like R744 and ammonia are not covered in this standard.

1.3 The requirements of following applications are not part of this standard:

a) Household refrigerators and household freezers;
b) Comfort and automotive air-conditioners;
c) Dehumidifiers;
d) Evaporative cooled condensers;
e) Condensing units without the compressor; and
f) Units supplied with evaporator.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revisions, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
302 (Part 1) : 2008	Safety of household and similar electrical appliances: Part 1 General requirements (*sixth revision*)
996 : 2009	Single phase a.c. induction motors for general purpose (*third revision*)
3615 : 2020	Glossary of terms used in refrigeration and air conditioning (*second revision*)
10617 : 2018	Hermetic compressors — Specification (*second revision*)
11329 : 2018	Finned type heat exchanger for room air conditioner (*first revision*)
16451 : 2018/ ISO 7010 : 2011	Graphical symbols — Safety colours and safety signs — Registered safety signs
16678 (Part 2) : 2018/ISO 5149 (Part 2) : 2014	Refrigerating systems and heat pumps — Safety and environmental requirements: Part 2 Design, construction, testing, marking and documentation
IS/IEC 60335-2-40 : 2018	Household and similar electrical appliances — Safety: Part 2-40 Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

3 TERMINOLOGY

For the purpose of this standard, the following definitions and definitions of IS 3615 shall apply.

3.1 Manufacturer — For this standard, the manufacturer is the company or organization, which evidences its responsibility by affixing its name or its nationally registered trademark or trade name, to the condensing unit.

3.2 Electrically Driven Open Type Compressor Water Cooled Condensing Unit — A unit consisting of a compressor, a drive motor, a water-cooled condenser, a drive assembly and other features as specified by the manufacturer with interconnecting piping mounted on a common base or any other arrangement.

3.3 Electrically Driven Open Type Compressor Air Cooled Condensing Unit — A unit consisting of a compressor, an air-cooled condenser, a fan, compressor drive motors (fan drive arrangement, if required) and other features as specified by the manufacturer with interconnecting piping. (The condenser with the fan and a fan drive can be installed remotely depending upon the capacity and the design).

3.4 Electrically Driven Semi Hermetic and Hermetic Type Compressor Water Cooled Condensing Unit — A unit consisting of a compressor, and other features as specified by the manufacturer with interconnecting piping all mounted on a common base or any other arrangement.

3.5 Electrically Driven Semi Hermetic and Hermetic Type Air Cooled Condensing Unit — A unit consisting of a compressor, an air-cooled condenser, a fan and other features as specified by the manufacturer with interconnecting piping all mounted on a common base for indoor and outdoor usage.

3.6 Coefficient of Performance (COP) — A ratio of the cooling capacity in watts (W) to the power input values in watts (W) at any given set of rating conditions expressed in watts/watt [W/W].

3.7 Energy Efficiency Ratio, (EER) — A ratio of the cooling capacity in btu/hour to the power input values in watts (W) at any given set of rating conditions.

3.8 Published Rating — The term published rating includes the all performance characteristics shown on the unit or published in specifications or other literature controlled by the manufacturer, at stated rating conditions.

3.8.1 *Application Rating* — The term application rating includes all the performance characteristics at conditions other than standard rating as declared by the manufacturer.

3.9 Rating Conditions — A set of operating conditions under which a single level of performance characteristics defined/published, and which causes only that level of performance to occur.

3.9.1 *Standard Ratings Conditions* — Rating conditions used as the basis of comparison for performance characteristics.

3.10 Refrigerating Capacity — The product of the mass flow rate of the refrigerant in the evaporator and the difference between the enthalpies of the refrigerant entering and exiting the condensing unit is the refrigeration effect (kW).

3.11 "Shall" or "Should" — "Shall" or "should" shall be interpreted as follows.

3.11.1 *Shall* — Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.11.2 *Should* — "Should," is used to indicate provisions which are not mandatory, but which are desirable as good practice.

4 COMPONENTS

4.1 Basic Components

Manufacturer shall define the scope of components that would get into assembly of the condensing unit. The following are the guidelines for understanding and selecting the components that would go into the assembly of the condensing units considering the end application.

A condensing unit shall comprise of the following basic components:

a) Hermetic sealed, semi-hermetic sealed or open type compressor with relevant accessories;

b) Drive arrangement for open type and variable capacity compressors;

c) Condenser air cooled or water cooled;

d) Condenser fan (applicable to air cooled type);

e) Water connections/fitting for water cooled condensers;

f) Interconnecting pipe and fittings;

g) Name plate;

h) Mounting frame; and

j) Provision for connecting electrical supply.

4.2 Auxiliary Components

The following items may be included on specific requirement; however, this is not complete list of items that can be added or deleted:

a) System protectors like liquid line refrigerant filter drier, suction line strainer, oil separator, accumulator, receiver;

b) Protection devices like oil pressure switch, solenoid valve, thermostat, HP/LP cut-out, safety valve or any other pressure relief device, thermostats;

c) Controlling devices like drive for variable speed compressor or open type drive, expansion device, electronic control board/controller, pressure controllers, fan speed regulators;

d) Structural components like mounting base, guards/shroud for unit as well as fan; and

e) Indicating instruments like pressure gages.

The scope of supply shall be defined by the manufacturer in the form of bill of material/technical specifications.

5 TECHNICAL REQUIREMENTS

These are the general guidelines which would help the manufacturers/customer/end users to identify the design aspects which are of importance considering the end application. The scope of supply shall be as per bill of material/technical specification.

5.1 Unit shall be constructed to withstand normal handling during transport and servicing. A validation of transport worthiness of the system should be carried out by the manufacturer.

5.2 The units meant for outdoor usage should qualify for the following:

Salt spray evaluation for the sheet metal components, base frame, structure etc. shall be as per **7.4.5.2** of IS 11329 for 72 h. If the intended application requires vigorous requirement (higher salt spray test hours than 72 h) it must be agreed between manufacturer and buyer.

5.3 Pipes and connections to moving or resiliently mounted parts neither transmit vibration excessively nor foul adjacent parts. The unit shall not make excessive vibration and noise during normal operation.

5.4 Each unit with the refrigerating/cooling capacity equal to one or more than 2 kW, at standard rating conditions should be considered for providing with safety measures against high and low pressure. The arrangement may be, pressure relief valve, bursting disc, fusible plug, soldered joint, special terminals, high/low pressure cut-out etc. or other suitable means.

5.5 Parts that need servicing or attention should be made easily accessible for for example, filter drier, pressure cut outs, electrical controls, power supply connection etc.

5.6 The hermetic compressor shall comply with the requirements of IS 10617.

5.7 Fan motors above 10 watts output shall be protected from overloading by thermal protector or any other arrangement sensitive to motor winding temperature or current or both.

5.8 The units to be operated with flammable/mildly flammable refrigerant (A3 and A2L). For safety **7.104**, **11.2.3**, and **22.119** as per IS/IEC 60335-2-40 shall apply.

5.9 In case of units operating with variable speed compressor, the drive ratings, voltage and frequency ratings used for publishing the system ratings should be specified by the manufacturer.

5.10 The specification for moisture content and the cleanliness level (residue level) in the system should be defined by the manufacturer as a part of the specification. Receivers, condenser receivers, oil separators and suction accumulators (tank type components) must have a positive holding charge of dry air or nitrogen having a dew point of −40 °C or lower. Pressure vessels shall meet the criteria of strength pressure test as per **9.3**.

5.11 All openings into refrigerant circuits must be adequately sealed to prevent entry of dirt, moisture or other foreign objects, to protect threaded fittings against damage and to prevent damage to ends of tubing of sweat fittings.

5.12 A positive pressure or holding charge inside the condensing unit is required to be maintained.

5.13 Fan motor of induction type shall comply with IS 996.

NOTE — For other types of fan motors, the requirements of IS 996 is not aplicable.

6 TESTING AND STANDARD RATING CONDITIONS

6.1 The condensing unit can be classified based on the evaporating temperature range as given in Table 1. The precise limits of the evaporating temperatures shall be according to the declared condensing unit specifications. Classification in Table 1 is indicative only.

6.2 Rating and Test Conditions

The performance of the condensing unit shall be specified at the standard rating conditions. Standard ratings shall be established at the conditions mentioned in Tables 2, 3, and 4.

Table 1 Classification of Condensing Units

(*Clause* 6.1)

Sl No.	Category	Applications/Usage	Evaporating Temperature Range Dew point (°C)
(1)	(2)	(3)	(4)
i)	Low Back Pressure (LBP)	Refrigerating and freezing of commercial and industrial applications	−40 to −10
ii)	Commercial Back Pressure or Medium Back pressure (CBP/LBP)	Refrigerating and cooling of commercial and industrial applications	−25 to +10
iii)	High Back Pressure (HBP)	Chilling and Industrial applications	−5 to +25

Table 2 Normal Load Conditions LBP

(*Clause* 6.2)

Sl No. (1)	Category (2)	Units (3)	LBP(A) (4)	LBP(B) (5)
i)	Evaporating temperature[1]	°C	–23.3	–35
ii)	Air inlet temperature to condenser (Dry bulb)	°C	35	35
iii)	Suction superheat	K	27.7	10
iv)	Return gas temperature[2]	°C	4.4	–25
v)	Subcooling temperature[3]	K	0	0
vi)	Voltage	V	230 V ~ 1 Phase 400 V ~ 3 Phase	
vii)	Frequency	Hz	50 Hz	

Table 3 Normal Load Conditions CBP/MBP

(*Clause* 6.2)

Sl No. (1)	Category (2)	Units (3)	MBP(A) (4)	MBP(B) (5)
i)	Evaporating temperature[1]	°C	–6.7	–10
ii)	Air inlet temperature to condenser (Dry bulb)	°C	35	35
iii)	Suction superheat	K	11.1	10
iv)	Return gas temperature[2]	°C	4.4	0
v)	Subcooling temperature[3]	K	0	0
vi)	Voltage	V	230 V ~ 1 Phase 400 V ~ 3 Phase	
vii)	Frequency	Hz	50 Hz	

Table 4 Normal Load Conditions HBP

(*Clause* 6.2)

Sl No. (1)	Category (2)	Units (3)	HBP(A) (4)	HBP(B) (5)
i)	Evaporating temperature[1]	°C	+7.2	+5
ii)	Air inlet temperature to condenser (Dry bulb)	°C	35	35
iii)	Suction superheat	K	11.1	15
iv)	Return gas temperature[2]	°C	18.3	20
v)	Subcooling temperature[3]	K	0	0
vi)	Voltage	V	230 V ~ 1 Phase 400 V ~ 3 Phase	
vii)	Frequency	Hz	50 Hz	

For water cooled condensing units, the inlet water temperature is 29 °C/outlet water temperature is 35 °C.

6.2.1 *Correction Factors*

The correction factors applicable to only cooling capacity data relating to superheat in Tables 2, 3, and 4 shall comprise:

a) Change in refrigerating cooling capacity as a function of superheat; and
b) Change in power absorbed is not a function of superheat.

Conversion factors or calculation method for different values of superheat shall be based on following formula data.

$$m_{\text{corrected}} = (1 + f_{\text{v}}\{(v_{\text{rated}}/v_{\text{corrected}}) - 1\}) \times m_{\text{rated}}$$

where

$m_{\text{corrected}}$ = Refrigerant mass flow rate at suction conditions, kg/s;
m_{rated} = Refrigerant mass flow rate at rated superheated conditions, kg/s;
$v_{\text{corrected}}$ = Specific volume at suction conditions m^3/kg;
v_{rated} = Specific volume at rated suction conditions m^3/kg; and
f_{v} = Volumetric efficiency correction factor, the correction factor will vary based on volumetric efficiency of compression technology being used, a value of (1) can be used for approximation. The manufacturer to provide precise value.

6.3 Standard Ratings

Standard ratings consists of reference points defined in subsequent Tables 2, 3, and 4, the following data shall be given:

a) Refrigerating capacity/cooling capacity;
b) Total power absorption including fan motors other factory supplied components; and
c) Co-efficient of performance (COP).

The following further information shall be provided upon request:

1) Application limits related to ambient air/water temperature (minimum and maximum); and
2) For water cooled condensing units: Water mass flow rate and pressure drop.

6.4 Application Ratings

These are the additional ratings which may be required considering the end application. For deriving the application ratings either manufacturer will define the operating conditions based on the intended usage or shall be as agreed upon with the end user.

Application ratings can be determined based on the testing or by estimated based on the published test data.

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[1] Evaporating temperature: In case of Azeotropic Mixtures dew point and midpoint evaporating temperature are same, for the refrigerants having glide more than 2 K manufacturer shall state clearly in the declaration/specifications about midpoint temperature or dew point temperature considered, for midpoint calculation refer Annex B and D.

[2] For external drive or accessible hermetic type condensing units return gas temperature of 18 °C shall be used.

[3] In case of variable speed condensing unit, compressor speed required to be mention by manufacturer for rated capacity declaration.

These ratings should made available upon request of the end user.

The parameters to be published generally should include above in **6.2** or any other parameters as agreed upon with the end user.

6.5 Tolerances

Following tolerances in Table 5 can be applied to manufacturer’s published performance in relation to measured data obtained at the standard rating points according to Annex C.

Table 5 Tolerances

(*Clause* 6.5)

Sl No. (1)	Item (2)	LBP (3)	MBP/CBP (4)	HBP (5)
i)	Refrigerating capacity	–90 percent	–90 percent	–92.5 percent
ii)	Power absorbed	+ 112.5 percent	+ 110 percent	+ 107.5 percent
iii)	EER/COP	+ 90 percent	+ 90 percent	+ 90 percent
iv)	Voltage		+/–1.5 percent	
v)	Frequency		+/–1 percent	

7 SPECIFICATIONS/DATA PUBLICATION

7.1 Performance Data

Published performance shall be based on data obtained from tests performed accordance with Annex C.

Manufacturer shall declare mean evaporating temperature or dew point temperature used to publish the performance data.

Manufacturer can choose to rate the condensing unit at dew point temperature even for refrigerants with glide.

Performance data to be given in either tabular form or graphical form or both, shall consist of following:

a) The refrigerating capacity/cooling capacity of condensing units;
b) Power consumed by condensing units;
c) Evaporating temperature (mean/dew point), at intervals not greater than 5 K;
d) Ambient temperature, at intervals not greater than 5 K;
e) Open compressors at rated speed; and
f) Motor compressors at rated voltage and frequency.

Please refer to Annex A for definition of evaporating temperature, ambient temperature and average air temperature measurements.

7.2 Part Load Performance Data (for Variable Speed or Multi Compressor)

Published performance shall be based on data obtained from tests performed accordance with Annex C. The performance data with capacity control shall be presented for the following:

a) All capacity control steps for condensing units with 2 to 4 control steps, example for blocked suction, condensing units with more than one compressor or multi speed compressor; and
b) Condensing units with more than 4 steps or other variable capacity (example variable speed or stepless) at maximum, minimum and at least one additional control step inside the control range.

NOTE — Regardless of the speed, the published data and measured data must be within the tolerance specified in **6.5**.

8 MARKING AND INSTRUCTIONS

8.1 Each unit shall have a name plate on which following information shall be marked in permanent and legible manner by manufacturer at an easily visible place within the unit:

a) Name of manufacturer;
b) Country of origin;
c) Type or model and serial number of the unit (shall be numerical and barcode for traceability);
d) Rated voltage phase and frequency — The product rated for dual voltage/dual frequency to be marked as dual voltage and dual frequency;
e) Refrigerant or refrigerant group;
f) Maximum working pressure; and
g) When flammable refrigerants are used, the flame symbol according to W021 of IS 16451/ISO 7010, shall be displayed with a minimum height of 10 mm, and the symbol need not be in color.

8.2 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act,* 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

8.3 Each condensing unit shall be accompanied on delivery by instructions for its use and maintenance printed on strong paper, cardboard or similar material. These instructions shall at least provide following information relating to:

a) Installation requirements;
b) Conditions of operation (starting, stopping);

c) Use of various control devices (thermostat, defrosting, etc.); and

d) Maintenance and cleaning the product.

9 SAFETY REQUIREMENTS

9.1 Tests

a) *Type Test* — The type tests shall consist of the tests that would be necessary to check up the performance and characteristics of the units and components.

    1) Provision for earthing [*see* **27** of IS 302 (Part 1)];

    2) Electrical strength test [*see* **13.3.2** of IS 302 (Part 1)]; and

    3) Running overload test for the fan motor [*see* **11.5** or **19.9** of IS 302 (Part 1)].

b) *Routine Test* — These shall consist of routine tests that would be conducted on each and every unit during production.

    1) High voltage at 1.5 kV and 5 m A leakage current for 1s;

    2) Leak test: Min 1 Mega Pascal, No leak [*see* IS 16678 (Part 2)/ISO 5149-2]; and

    3) Fan on/off test to ensure fan is rotating basis input power and no touching with other mating parts to avoid damage/touching noise while in operation.

9.2 Pressure vessels to meet the criteria of strength pressure test as per **4.4.2**. Strength-pressure test for components as per IS 16678 (Part 2)/ISO 5149-2.

9.3 Protection Against Moving Parts

All moving parts (for example, fan blades, blower wheels, pulleys, and belts) that if accidentally contacted, could cause bodily injury shall be guarded against accidental contact by an enclosure or a screen requiring the use of tools for removal or permanently attached.

ANNEX A

(*Clause* 7.1)

DEFINITIONS

A-1 EVAPORATING TEMPERATURE

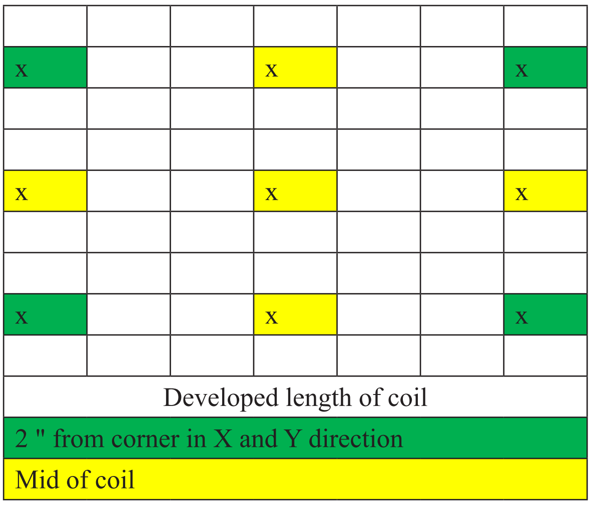
Temperature at which a fluid vaporizes at a given pressure.

A-2 AMBIENT TEMPERATURE

Average Air temperature around the condensing unit.

A-3 AVERAGE AIR TEMPERATURE ENTERING THE CONDENSER

Average air temperature of all temperature measuring media (thermocouple etc.) located at condenser.



🟩 x			🟨 x			🟩 x
🟨 x			🟨 x			🟨 x
🟩 x			🟨 x			🟩 x
Developed length of coil						
🟩 2 " from corner in X and Y direction						
🟨 Mid of coil						

ANNEX B

(*Clause* 6.2)

DETERMINATION OF EVAPORATING TEMPERATURE

(*Normative*)

B-1 DETERMINATION OF EVAPORATING TEMPERATURE WITH REFRIGERANT MIXTURES

For refrigerants with glide the evaporating temperature is the arithmetic mean of the evaporator inlet temperature and dew point temperature at the condensing unit inlet pressure with the following assumptions: isenthalpic expansion from condensing unit outlet temperature to the condensing unit inlet pressure, isobaric evaporation, no suction line pressure drop and temperature changes of the refrigerant are linear with the enthalpy during evaporation and effects of oil circulation are ignored.

The determination of the inlet temperature in the area of two phases is done by linear interpolation between dew point and bubble point temperature at evaporating pressure, via the enthalpy at the expansion device inlet.

$$t_{\mathrm{om}} = \frac{t_{\mathrm{o1}} + t_{\mathrm{oD}}}{2} \qquad (1)$$

$$t_{\mathrm{o1}} = t_{\mathrm{oB}} + (t_{\mathrm{oD}} - t_{\mathrm{oB}}) \cdot \frac{h_{\mathrm{EX}} - h_{\mathrm{oB}}}{h_{\mathrm{oD}} - h_{\mathrm{oB}}} \qquad (2)$$

where

t_{om} = is the arithmetic mean evaporating temperature, expressed in degree Celsius (°C);

t_{o1} = is the temperature at the inlet of the evaporator at unit inlet pressure, expressed in degree Celsius (°C);

t_{oD} = is the temperature of the evaporating dew point at unit inlet pressure, expressed in degree Celsius (°C);

t_{oB} = is the temperature of the bubble point at unit inlet pressure, expressed in degree Celsius (°C);

h_{EX} = is the enthalpy at the expansion device inlet, expressed in Joule per kilogram (J/kg);

h_{oB} = is the enthalpy at the bubble point at condensing unit inlet pressure, expressed in Joule per kilogram (J/kg);

h_{oD} = is the enthalpy at the dew point at condensing unit inlet pressure, expressed in Joule per kilogram (J/kg).

ANNEX C

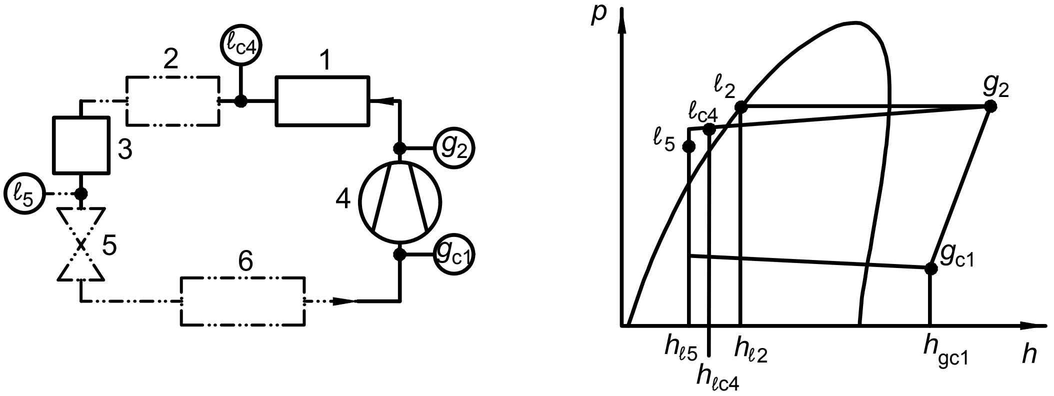
(*Clauses* 6.5, 7.1, *and* 7.2)

TESTING METHODOLOGY OF CONDENSING UNITS

C-1 TESTING SCHEMATIC AND PROCEDURE

The refrigerant flow is determined using either a volumetric or a mass flow meter inserted into the liquid line. The flow meter is connected to the liquid line between the condensing unit outlet and expansion device.

The cooling capacity calculation is product of Mass flow measured and relative enthalpy difference inlet/outlet of condensing unit. Minimum stabilized data for 30 min should be considered for capacity, power and COP declaration.



a) CIRCUIT DIAGRAM

b) PRESSURE VS ENTHALPY DIAGRAM

KEY

1	CONDENSER
2	SUB-COOLER
3	LIQUID FLOW METER
4	COMPRESSOR
5	EXPANSION DEVICE
6	EVAPORATOR

FIG. 1 TESTING SCHEMATIC OF CONDENSING UNIT

C-2 MEASURED DATA AND PERMISSIBLE DEVIATION

Sl No. (1)	*Measured Quantity* (2)	*Permissible Deviation* (3)	*Measuring/Controlling Instrument* (4)	*Accuracy of Instrument* (5)	*Location of Measurement Instrument* (6)
i)	Gauge Pressure at inlet and outlet of condensing unit	1 percent	U/Bourdon tube/diaphragm manometers/pressure transducers	1 percent	6”±/1” (15.24 ± 2.54 cm) at inlet and outlet of condensing unit
ii)	Refrigerant temperature at inlet of condensing unit	+/– 3 °C	Thermocouples	+/– 0.5 °C	6”±/1” (15.24 ± 2.54 cm) at inlet and outlet of condensing unit
iii)	Air inlet temperature to condenser	+/– 1.5 °C of temperature at mentioned rated conditions	Thermocouples	+/– 0.5 °C	Refer figure
iv)	Nominal compressor speed	+/– 1 percent			
v)	Nominal electrical voltage	+/– 1.5 percent of nominal voltage at rating conditions	Integrating instrument	+/– 0.5 percent	Electric/control box of condensing unit
vi)	Nominal electrical frequency	+/– 1 percent	Integrating instrument	+/– 0.5 percent	Electric/control box of condensing unit
vii)	Refrigerant flow	–	Liquid refrigerant flow meter	+/– 1 percent	Outlet of condensing unit and before Evaporating device
viii)	Water flow	+/– 1.5 percent	Liquid/water flow meter	+/– 1 percent	
ix)	Liquid temperature at condensing unit outlet	+/– 1 °C	Thermocouples	+/– 0.5 °C	6±/1” (15.24 ± 2.54 cm) at inlet and outlet of condensing unit

Ensure instruments are caliberated.

ANNEX D

CYCLE PROCESS

(*Informative*)

C-1 CYCLE PROCESS

For reference, Fig. 2 shows a typical single stage cycle recommended for single component refrigerants and azeotropic mixtures. As shown, the evaporating and condensing processes occur at fixed temperatures to and t_c respectively.

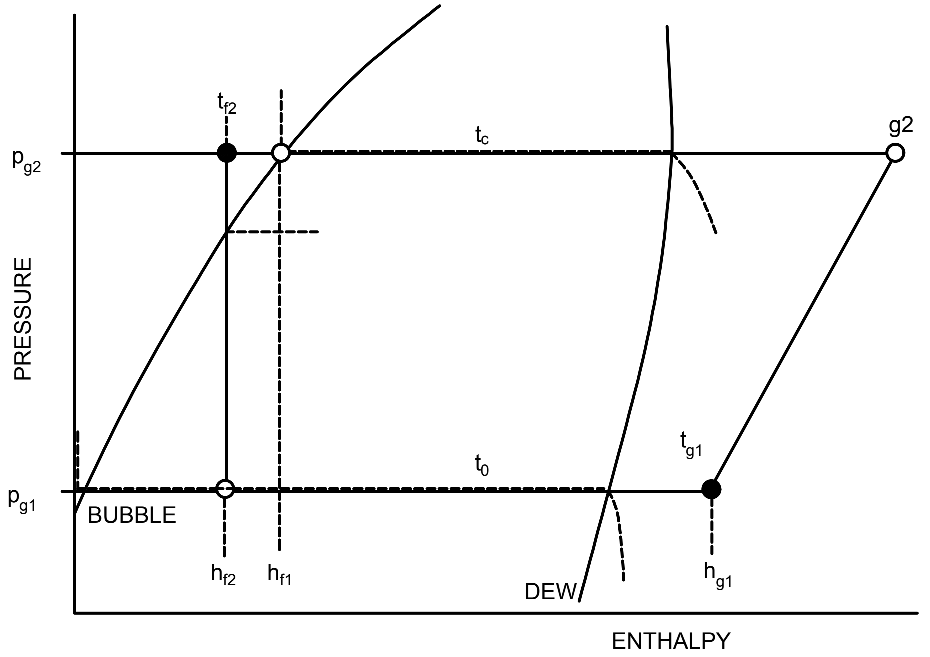


Fig. 2 Cycle Process

C-2 SYMBOLS AND SUBSCRIPTS

f_1 = Bubble point at condensing process;

g_1 = Point where the refrigerant enters the compression process;

g_2 = Point where the refrigerant leaves the compression process;

h_{f1} = Enthalpy of the refrigerant at bubble point of condensing process;

h_{f2} = Enthalpy of the subcooled refrigerant liquid entering the expansion process;

h_{g1} = Enthalpy of the refrigerant gas entering the compression process;

m_f = Refrigerant mass flow rate;

p_{g1} = Compressor suction dew point pressure;

p_{g2} = Compressor discharge dew point pressure;

t_c = Condensing temperature;

$t_{c'}$ = Bubble point temperature at condensing process;

$t_{c''}$ = Dew point temperature at condensing process;

$t_{c,m}$ = Mean condensing temperature;

t_{f1} = Temperature at which the subcooled liquid exits the expansion process;

t_{f2} = Temperature at which the subcooled liquid enters the expansion process;

t_{g1} = Temperature of the refrigerant entering the compression process;

t_0 = Evaporating temperature;

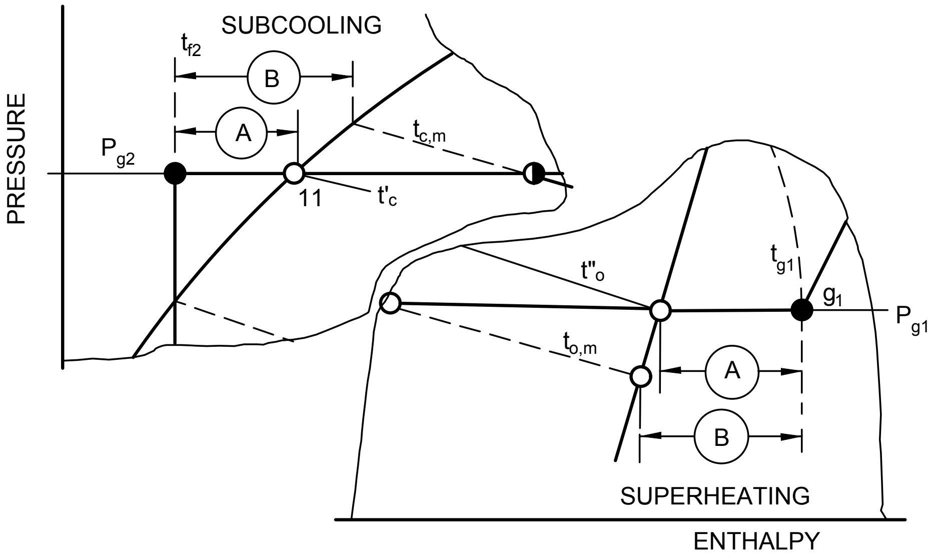
$t_{0''}$ = Dew point temperature at evaporation process;

t_{01} = Temperature at the outlet of the expansion process and inlet to the evaporation process;

$t_{0,m}$ = Mean evaporating temperature;

Δt_{sf} = Refrigerant subcooling; and

Δt_{sg} = Refrigerant superheat.



ANNEX E

(*Foreword*)

COMMITTEE COMPOSITION

Refrigeration and Air Conditioning Sectional Committee, MED 03

Organization	*Representative(s)*
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